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U.S. DEPARTMENT OF AGRICULTURE - FOREST SERVICE  
PACIFIC SOUTHWEST FOREST AND RANGE EXPERIMENT STATION  
Division of Forest Insect Research

FOREST INSECT CONDITIONS  
CANNELL MEADOWS WORKING CIRCLE  
SEQUOIA NATIONAL FOREST  
APPRaisal SURVEY

SPRING 1959

By Ralph C. Hall, Entomologist

In mid-April 1959 the Station was requested by the Region-5 office, Forest Service, to survey insect conditions in the Cannell Meadows Working Circle. This request was prompted by a report from the Forest Supervisor to the effect that insect-caused losses in this area appeared to be continuing at a high level. 1/

Prior to 1959 the most recent ground survey of insect conditions conducted by the Station in the Cannell Meadows Working Circle was one made two years ago. This was a joint appraisal-operational type survey staged in June 1957. It provided estimates of damage to timber caused by insects during the preceding two years. 2/ An aerial examination made by the Station in April 1958 showed that scattered heavy losses were continuing. 3/

The first step taken by the Station to reappraise insect damage at Cannell Meadows in 1959 was to again examine the area from the air. The purpose was to check the conditions reported by local forest officers, and to determine from an entomological standpoint whether an additional ground survey was indicated.

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1/ See memo Apr. 13, 1959 to Regional Forester, from Forest Supervisor, Sequoia; subject S-Control-Insects; S-Plans - Timber Management.

2/ Hall, Ralph C. Forest insect conditions, Cannell Meadows Working Circle, Sequoia National Forest, Appraisal Survey, Spring 1957. CF&RES, Berkeley, Calif. 7 pp., illus. July 16, 1957. (mimeo).

3/ Wickman, B.E. Forest insect aerial survey, California region, spring 1958. CF&RES, Berkeley, Calif. 15 pp., illus. May 21, 1958 (multilith).

The aerial survey was made jointly by Station and Forest personnel on April 23. <sup>4/</sup> It showed that losses were continuing at a generally high level, and that in some parts of the Cannell Meadows District they appeared to have increased in the last year. In view of this trend, an appraisal-operational type survey, similar to the one conducted in 1957, was proposed.

The ground survey, directed by the author, was made jointly by Station, Region and Forest personnel. The plan followed was the same as that used in 1957 <sup>5/</sup> except for minor modifications. The field work was done May 5-8 and May 26-28. Personnel participating were R.C. Hall from the Station; J.L. Averell from the Region; and J.V. Flynn, R. Churchill, R. Phillips and D. Biddison from the Sequoia Forest.

#### The Cannell Meadows Area

Following is a brief general description of area and stand conditions taken from the previous report. <sup>2/</sup>

"The Cannell Meadows Working Circle comprises an area of about 105,000 timbered acres containing about 3 billion board-feet of merchantable timber, lying between the Kern River and U.S. Route 395 . . . . A major portion of the area is a rugged plateau ranging generally in elevation from 8 to over 9 thousand feet . . . . This plateau is broken up by many steep drainages and peaks.

"The timber type ranges from pure pine to pure fir. The Jeffrey pine type predominates, followed by true firs, pine-fir mixtures, and lodgepole. Site range from very good site II to very poor site V, with the average site being a good site IV.

"Tree species in order of their abundance are Jeffrey pine, red fir, white fir, lodgepole pine, western white pine, sugar pine, incense-cedar, and ponderosa pine.

"The total per-acre volume of all species is estimated at about 28,600 board-feet. Jeffrey pine makes up about 38 percent of this total, followed in order by red fir with about 28 percent, white fir with 25 percent, with the balance of 9 percent made up of the other species."

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<sup>4/</sup> See memo Apr. 30, 1959 to Regional Forester, from Director, PSW & FNRES; subject RX-PSW - Insect Survey Program, Aerial Survey - Sequoia N.F., Cannell Meadows, Greenhorn and Tule River District.

<sup>5/</sup> Wickman, B.E. Study Plan for the Cannell Meadows Working Circle. Appraisal survey, Sequoia National Forest. CF&RES, Berkeley, Calif. May 17, 1957.

### Methods

In the 1957 survey the Cannell Meadows Working Circle was divided into three segments or zones for purposes of the survey. The northern zone was designated as the Blackrock, the central zone Sherman Peak, and the southern zone Bartolas. In the 1959 survey the Working Circle was divided into four segments by splitting the Bartolas zone into two parts. The northern part, coinciding in general with the Salmon Creek Sale area, was designated as the Salmon Creek zone. The southern part, containing the balance of the old Bartolas zone, was designated the Cannell zone (fig. 1).

The methods used in sampling tree mortality in the four zones were essentially the same as those used in 1957. Circular  $\frac{1}{2}$ -acre plots were established at 5-chain intervals along cruise lines spaced about 20 chains apart, or along existing trails. Cruising was done both on foot and on horseback. The latter method was used along trails. In some cases two men on horseback worked as a team, taking two plots at 5-chain intervals along the trail,  $2\frac{1}{2}$  chains on each side. Data recorded on each plot included the number of trees killed in 1957 and 1958, by tree species, diameter, and insect species responsible for or associated with death.

The sampling design called for the establishment of a minimum of 400 plots in each zone. This intensity of sampling was expected to yield estimates of the total timber volume (all species) killed annually by zones subject to a sampling error of not more than 25 percent for each zone, and not more than 15 percent for the whole Working Circle. As shown in table 1, a total of 1,928 plots was established. The only zone where sampling was below the level of intensity called for in the plan was Sherman Peak. In all zones the sampling error in most cases was within the prescribed limit.

### Insect and Host Species

Following are the principal tree-killing insects and the host tree species with which they are commonly associated around Cannell Meadows:

<u>Insect</u>	<u>Host</u>
Jeffrey pine beetle ( <u>Dendroctonus</u> <u>jeffreyi</u> Hopk.)	Jeffrey pine
California flatheaded borer ( <u>Melanophila californica</u> Van D.)	Jeffrey pine
Mountain pine beetle ( <u>Dendroctonus</u> <u>monticolae</u> Hopk.)	Lodgepole pine Sugar pine Western white pine

# CANNELL MEADOWS INSECT APPRAISAL

1959

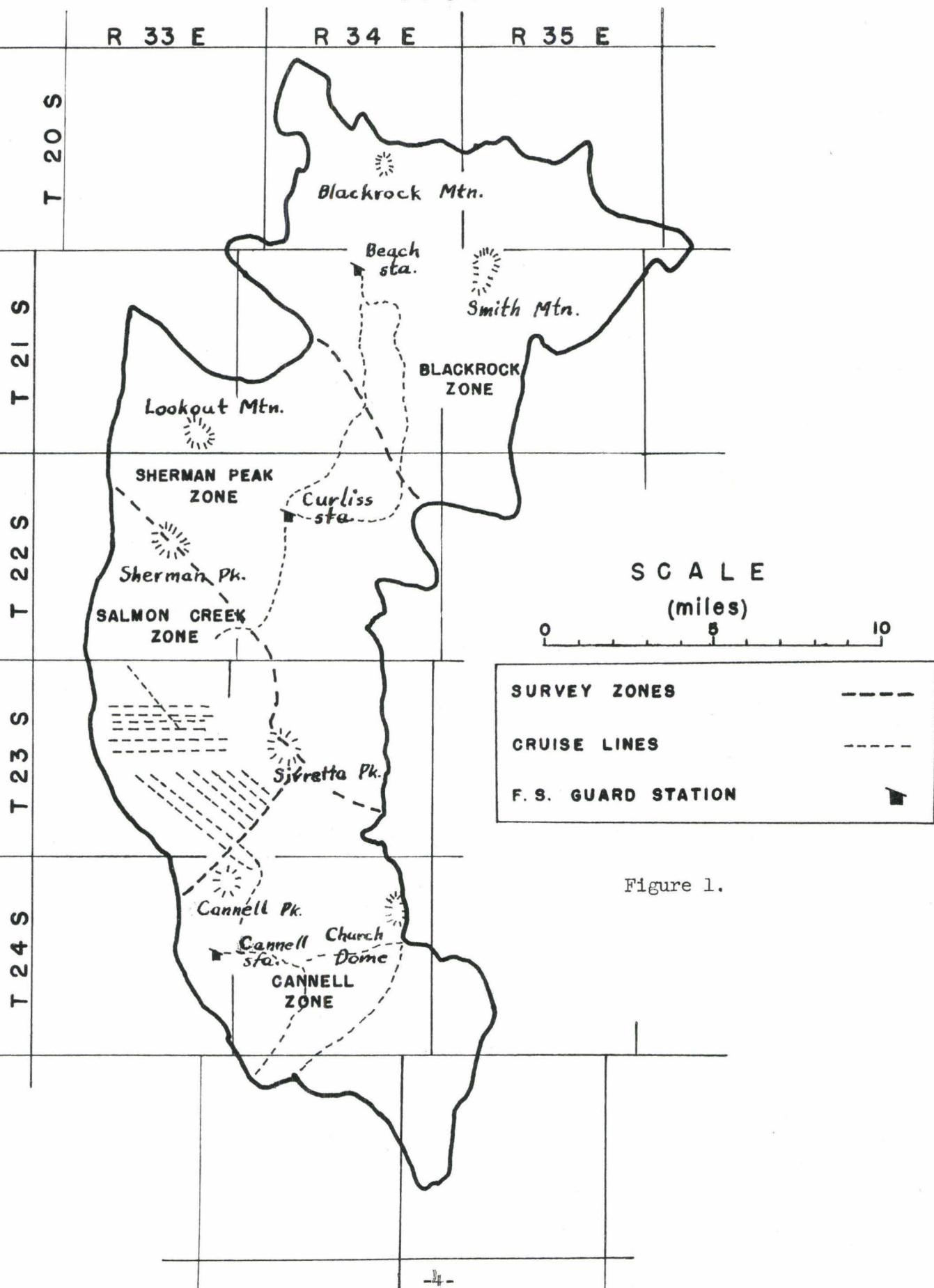


Figure 1.

Fir engraver (Scolytus ventralis Lec.) Red fir and white fir

Roundheaded fir borer (Tetropium abietis Fall) Red fir and white fir

Ponderosa pine occurs in a very limited area on the western fringe of the Working Circle, but no western pine beetle was found during either the 1957 or 1959 surveys. In 1959 no infested sugar pine or western white pine was found on the plots, but some were observed off the plots.

#### Tree Mortality

The data on tree mortality obtained in the ground survey are summarized in tables 1 and 2. In general they substantiate observations made during the aerial survey, which pointed to continuing high losses. In 1958 the average per-acre volume killed for all species over the entire Working Circle was 312 board-feet; in 1957 it was 147 board-feet. The 1957 mortality amounts to 0.52 percent of the residual stand. This is about normal for old-growth forests of this type. Mortality in 1958, which was 1.09 percent of stand, was more than twice normal, however.

Mortality was heaviest in Jeffrey pine. The data show that the volume killed in the last two years was about  $1\frac{1}{2}$  times the amount killed in 1955-56 (table 3). Mortality in red fir and white fir showed a slight decrease, but that in lodgepole pine showed a very marked decrease. The increase in Jeffrey pine loss nearly compensated for the decrease in the other species, but the total average per-acre loss in all species, (459 board-feet) for the 1957-58 period was nearly the same as for 1955-56 period.

By zones, tree mortality for the 1957-58 period was greatest (608 board-feet per acre) in the Sherman Peak area. However, Jeffrey pine loss for this period was most severe in the Salmon Peak zone (table 3). By years (1957 versus 1958), losses in all species were greatest in 1958 (table 1). In terms of percent of stand killed, Jeffrey pine mortality during 1958 was nearly four times normal, red fir mortality about twice normal, and white fir mortality slightly below normal (table 4). As in the 1957 appraisal it was found that on the average the dead trees were of large diameter. The volume of the average tree killed in 1958 was 1,800 board-feet; in 1957 it was 1,370 board-feet.

The accuracy of the volume estimates of timber killed is shown by the data in table 2. All of the volume estimates of 1958 mortality fell within the 25 percent sampling error prescribed. Only two of the estimates of 1957 mortality met this requirement, i.e. the ones for Salmon Creek and Sherman Peak. The sampling error of mortality estimates for the entire Working Circle fell well below 15 percent for both years.

Table 1.--Estimated tree mortality per acre by zone, tree species and year -  
Cannell Meadows Working Circle

1958 Mortality

Zone	No. of plots	Jeffrey pine	White fir	Red fir	Lodgepole pine	All species
-----Board-feet per acre-----						
Salmon Creek	763	268 ± 48	42 ± 28	26 ± 15	--	336 ± 52
Cannell	428	211 ± 56	--	37 ± 25	--	248 ± 62
Combined (Old Bartolas) (1,191)		248 ± 37	27 ± 9	30 ± 10	--	305 ± 40
Sherman Peak	323	178 ± 81	31 ± 18	238 ± 77	--	447 ± 112
Blackrock	414	106 ± 37	40 ± 19	78 ± 33	3 ± 2	227 ± 50
All areas	1,928	206 ± 27	30 ± 7	75 ± 17	1 ± 0.3	312 ± 33

1957 Mortality

Salmon Creek	763	138 ± 28	21 ± 9	13 ± 5	1 ± 0.6	173 ± 32
Cannell	428	95 ± 33	5 ± 2	43 ± 25	--	143 ± 42
Combined (Old Bartolas) (1,191)		122 ± 21	15 ± 6	24 ± 9	0.4 ± 0.2	162 ± 26
Sherman Peak	323	30 ± 20	2 ± 1	129 ± 28	--	161 ± 35
Blackrock	414	42 ± 22	9 ± 6	27 ± 13	14 ± 10	92 ± 29
All areas	1,928	90 ± 16	12 ± 5	42 ± 11	3 ± 1	147 ± 19

Table 2.--Number of trees and volume killed per acre for all species by zone and year -  
Cannell Meadows Working Circle

1958 Mortality

Zone	Volume	Standard error	Sampling error	Trees	Standard error	Sampling error	Volume of average dead tree
	<u>Board-feet</u>		<u>Percent</u>	<u>Number</u>		<u>Percent</u>	<u>Board-feet</u>
Salmon Creek	336	± 52	15.5	0.186	± 0.027	14.5	1,800
Cannell	248	± 62	25.0	0.107	± 0.024	22.4	2,320
Combined (Old Bartolas)	305	± 40	13.1	0.158	± 0.019	12.0	1,930
Sherman Peak	447	± 112	25.0	0.204	± 0.045	22.0	2,190
Blackrock	227	± 50	22.0	0.184	± 0.029	15.8	1,230
All areas	312	± 33	10.6	0.171	± 0.016	9.3	1,820
<u>1957 Mortality</u>							
Salmon Creek	173	± 32	18.5	0.128	± 0.022	17.2	1,350
Cannell							
Combined (Old Bartolas)	162	± 26	16.0	0.119	± 0.018	15.1	1,360
Sherman Peak	161	± 35	21.7	0.074	± 0.022	29.7	2,180
Blackrock	92	± 29	31.5	0.097	± 0.022	22.7	950
All areas	147	± 19	12.9	0.107	± 0.013	12.1	1,370

Table 3.--Estimated tree mortality for 2-year periods by species, from the 1957  
and 1959 surveys

Zone	Jeffrey pine	White fir	Red fir	Lodgepole pine	Sugar pine	All species
	1955-56:1957-58	1955-56:1957-58	1955-56:1957-58	1955-56:1957-58	1955-56:1957-58	1955-56:1957-58
Salmon Creek	406	63	39	1.0	0	509
Cannell Combined (old Bartolas)	306	5	80	0.0	0	391
Sherman Peak	274	370	11	1.0	35	408
Blackrock	197	208	33	367	209	608
All areas	66	148	103	105	54	223
	195	296	42	135	117	459

Table 4.--Estimated tree mortality in percent of stand, by species, by years

Year	Tree species					
	Jeffrey pine: Red fir: White fir: Lodgepole pine: Sugar pine: All species					
-----Percent of residual stand per acre 1/-----						
1958	1.97	0.97	0.44	0.07	--	1.09
1957	.86	0.55	0.18	0.21	--	0.52
1956	1.11	0.83	0.27	2.45	2/7.60	0.90
1955	0.76	0.94	0.56	2.86	0.10	0.84

1/ Computed by dividing the residual per-acre volume of the individual species into the per-acre volume of that species killed, for the year indicated.

2/ Very small sample.

### Insect Infestation

Of the several insects responsible for tree mortality in the Cannell Meadows Working Circle, the Jeffrey pine beetle is most abundant. It is estimated that about 90 percent of the mortality in Jeffrey pine - the most prevalent tree species - is due to this bark beetle. The remaining 10 percent is attributed to the California flatheaded borer. Losses due to the latter insect were restricted mostly to the northern fringe area in the Salmon Creek zone.

At the time of the survey, the Jeffrey pine beetle broods were mostly in the larval and prepupal stages, but about 20 percent were pupae or callow adults. The California flatheaded borer was principally in the prepupal stage, with an occasional pupa present. The Jeffrey pine beetle infestation appeared to be very aggressive. In 26 trees examined to observe the condition of the broods, heavy populations were found in all but one tree. Another indication of the aggressive nature of the infestation was the tendency for the attacked trees to occur in groups. This tendency was particularly marked in the Salmon Creek and Cannell zones (fig. 2). Groups of up to 7 merchantable trees were observed in the former, and up to 3 in the latter area. Heavy local concentrations were also noted north of Poison Meadow, east of Taylor Meadow, and south of Beach Meadow. Throughout the balance of the Working Circle beetle-killed Jeffrey pine trees occurred singly or in small groups of no more than 3 trees.

The fir engraver was the insect most commonly responsible for mortality in red and white fir. Some trees attacked by this bark beetle also were attacked at the base by the roundheaded fir borer. The broods of both species were almost entirely large larvae at the time of the survey. The infestation of these species also showed some grouping tendencies, but usually in small poles near a larger beetle-killed tree.

Some tree diseases appeared to be involved in the mortality, but no dead trees were found without evidence of attack by primary insects. Tree diseases observed were the Jeffrey pine limb rust and mistletoe. The limb rust was the principal disease noted, but its occurrence was localized generally south of Poison Meadow and in the Cannell and Sherman Peak zones. Mistletoe was very frequently found in association with red fir mortality, and in many cases it appeared that the insects attacked after the tree was seriously weakened by the disease. In white fir there was little evidence of mistletoe or other diseases.

### Discussion

During the past four years insects have killed an estimated 100 million board-feet of merchantable timber in the Cannell Meadows Working Circle. It is estimated that more than half of this mortality is made up of Jeffrey pine, and most of the balance red and white fir. Much of this mortality has occurred in overmature decadent trees.



A



B

Figure 2.--Losses in Jeffrey pine caused by the Jeffrey pine beetle in the Salmon Creek zone. A - Current group-loss in 5 merchantable trees killed in 1958. B - Current and older loss; 4 merchantable trees killed in 1958 and 6 trees killed previously.

Effective methods for controlling the beetles that cause losses in red and white fir remain to be perfected. However, there are two possibilities for controlling the Jeffrey pine beetle and the California flat-headed borer. One is through direct control measures designed to reduce beetle populations by cutting and chemical treatment of the infested trees. The other is through indirect control, involving the removal of the beetle-susceptible or high-risk trees in a sanitation-salvage logging operation. Direct control would help reduce the losses temporarily, but would not have as long-lasting benefits as sanitation-salvage. This is because direct control does not remove the types of trees in which the beetles seem to prefer to breed as does sanitation-salvage.

In the Cannell Meadows Working Circle as in other old-growth Jeffrey pine stands, the decadent trees which would be removed through sanitation-salvage appear to sustain the greatest mortality. This was clearly demonstrated by data collected in the 1959 survey. In the portion of the Salmon Creek Sale which had already been marked for cutting, a sample of 81 insect-killed trees were examined to determine how many had been marked as high risk. The count showed 77 trees, or 95 percent in this category.

Direct control aimed at suppressing losses in Jeffrey pine would be costly. About 7,000 trees are estimated to be currently infested. At \$35 per tree, the total cost of treating the trees would be \$245,000. Indirect control through sanitation-salvage could be expected to return a profit from the sale of the Jeffrey pine logs and the salvage of dead trees of other species.

If no action is taken to control the insect infestation in Jeffrey pine, the damage will probably continue at least for the next year or two, perhaps longer. The aggressive character of the current Jeffrey pine beetle infestation, coupled with the fact the precipitation for the area is below normal this year, points to continued high losses for the immediate future. In the normal course of events, however, it is unlikely that insect damage will continue at a sustained high level indefinitely. It is more likely to fluctuate, much as it has over the past four years, barring unforeseen developments such as widespread windthrow, prolonged drought, or other catastrophe.

Berkeley, California  
July 9, 1959